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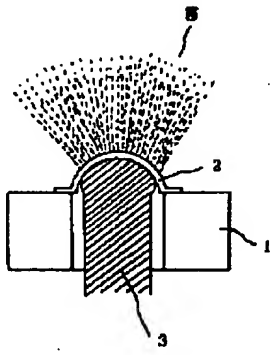
# (54) ULTRASONIC SPRAYING APPARATUS

(57) Abstract:

PURPOSE: To attempt to improve spraying efficiency and to make the amt. of spraying large by providing a lot of holes in an oscillating part surrounded by a fixed part fixed by means of a piezoelectric oscillator and making at least a part of the oscillating part into a curved structure.

CONSTITUTION: When a composite body consisting of a piezoelectric oscillator 1 and an oscillating body 2 is driven, the piezoelectric oscillator 1 is oscillated and the oscillation is transmitted to the oscillating body 2. A liq. fed to the lower face of the oscillating body 2 being brought into contact with a liq. holding material 3 is sprayed through holes provided in the oscillating body 2 according to oscillation of the oscillating body 2. The direction of spraying can be diverged as the central part of the oscillating body 2 is curved into a concave or convex curved structure, with which the liq. holding material is brought into contact. A simple and lightweight structure can be obtd. thereby and spraying efficiency, a large amt. of spraying and fineness and uniformity of the sprayed particle can be improved thereby, too and the direction of spraying can be diverged or converged.





* NOTICES *



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## CLAIMS

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[Claim(s)]
[Claim 1] In the ultrasonic atomization equipment which atomizes a liquid by the elastic vibration which the piezoelectric transducer was made to generate with the ultrasonic exciter which comes to fix an oscillating object Said piezoelectric transducer consists of piezoelectric ceramics and the electrodes A and B currently formed in the both-ends side perpendicular to the thickness direction of these piezoelectric ceramics, respectively. Said piezoelectric ceramics It has the through hole penetrated in parallel with the thickness direction of these piezoelectric ceramics, and the form of a cross section perpendicular to said thickness direction constitutes frame type structure. Said thickness lay length, A ratio with the minimum distance of a said frame type rim and a common-law marriage is equal to about 1. Said oscillating object The fixing section which has prepared opening of said through hole in the interior of a wrap location or this through hole at at least one place, and fixed to said piezoelectric transducer, It is ultrasonic atomization equipment which consists of the oscillating section surrounded by this fixing section, has established many holes in said oscillating section, and is characterized by said a part of oscillating section [ at least ] having constituted curve structure.
[Claim 2] Ultrasonic atomization equipment according to claim 1 characterized by said frame type being in a circle.
[Claim 3] It is ultrasonic atomization equipment according to claim 1 or 2 which a means to supply said liquid to said oscillating section is equipped with the liquid-retaining material which absorbs a liquid and supplies this liquid to said oscillating section, and is characterized by this liquid-retaining material being contacted by the crevice or heights of said curve structure.
[Claim 4] Ultrasonic atomization equipment according to claim 1, 2, or 3 characterized by one opening area of said oscillating section and the opening area of another side in said hole differing from each other mutually.
[Claim 5] The resonance frequency of said piezoelectric transducer is ultrasonic atomization equipment according to claim 1, 2, 3, or 4 characterized by being almost equal to the resonance frequency in the complex of this piezoelectric transducer and said oscillating object.

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[Translation done.]

## DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the ultrasonic atomization equipment which atomizes a liquid by the elastic vibration generated with the ultrasonic exciter.
[0002]
[Description of the Prior Art] As conventional ultrasonic atomization equipment, the ultrasonic atomization equipment and the nebulizer adapting a suspension run undergarment mold trembler are mentioned. Although the atomization equipment by suspension run undergarment mold vibrator is a thing using the supersonic wave of the frequency of several 10kHz and has the advantage in which a lot of fog may be generated, its structure is complicated and has it in accordance with the demerit in which equipment is large-scale. On the other hand, a nebulizer is a thing using the supersonic wave of an MHz field, and although it has the advantage of a particle being minute and excelling in homogeneity, it has the demerit in which it is difficult to generate a lot of [ atomization effectiveness is bad and ] fog with low power. That is, with conventional ultrasonic atomization equipment, there was a difficulty in either the minute nature of atomization effectiveness, abundant atomization, and a particle, or drive power-source cost.
[0003]
[Problem(s) to be Solved by the Invention] The purpose of this invention is seen from every field of being small and that the minute nature of atomization effectiveness, abundant atomization, and a particle and homogeneity, and equipment are lightweight, that structure is easy, and drive power-source cost to offer the ultrasonic atomization equipment whose satisfaction is possible.
[0004]
[Means for Solving the Problem] In the ultrasonic atomization equipment to which ultrasonic atomization equipment according to claim 1 atomizes a liquid by the elastic vibration which the piezoelectric transducer was made to generate with the ultrasonic exciter which comes to fix an oscillating object Said piezoelectric transducer consists of piezoelectric ceramics and the electrodes A and B currently formed in the both-ends side perpendicular to the thickness direction of these piezoelectric ceramics, respectively. Said piezoelectric ceramics It has the through hole penetrated in parallel with the thickness direction of these piezoelectric ceramics, and the form of a cross section perpendicular to said thickness direction constitutes frame type structure. Said thickness lay length, A ratio with the minimum distance of a said frame type rim and a common-law marriage is equal to about 1. Said oscillating object The fixing section which has prepared opening of said through hole in the interior of a wrap location or this through hole at at least one place, and fixed to said piezoelectric transducer, It consists of the oscillating section surrounded by this fixing section, many holes are established in said oscillating section, and it is characterized by said a part of oscillating section [ at least ] having constituted curve structure.
[0005] Ultrasonic atomization equipment according to claim 2 is characterized by said frame type being in a circle.
[0006] A means by which ultrasonic atomization equipment according to claim 3 supplies said liquid to said oscillating section is equipped with the liquid-retaining material which absorbs a liquid and supplies this liquid to said oscillating section, and this liquid-retaining material is characterized by being contacted by the crevice or heights of said curve structure.
[0007] Ultrasonic atomization equipment according to claim 4 is characterized by one opening area of said oscillating section and the opening area of another side in said hole differing from each other mutually.
[0008] Ultrasonic atomization equipment according to claim 5 is characterized by the resonance frequency of said piezoelectric transducer being almost equal to the resonance frequency in the complex of this piezoelectric transducer and said oscillating object.
[0009]

[Function] At the time of use of the ultrasonic atomization equipment of this invention, the AC signal which has a frequency almost equal to the resonance frequency of the complex of said piezoelectric transducer and said oscillating object is impressed to said piezoelectric transducer, and said piezoelectric transducer is excited. Excitation of said piezoelectric transducer vibrates said oscillating object. The liquid supplied to said oscillating object is atomized through the hole established in said oscillating section. The minute nature of a particle and homogeneity can be urged to the atomization which lets a hole pass, and, moreover, it can increase atomization effectiveness. Moreover, a lot of atomization can not only be realized with a low power, but can make the miniaturization of equipment easy from atomization effectiveness being high. Since a self-excitation type drive is also possible and a drive by the cell is also easy, a drive with a low power is attained in the form where it can respond to an environmental variation. Moreover, since it has constituted curve structure, if said a part of oscillating section [ at least ] is possible, it can close emission of a fog's existence region.

[0010] Said piezoelectric transducer consists of piezoelectric ceramics and the electrodes A and B currently formed in the both-ends side perpendicular to the thickness direction of said piezoelectric ceramics, respectively. Alternating voltage is impressed to said piezoelectric transducer through these electrodes A and B, and said piezoelectric transducer is excited. Ultrasonic atomization equipment can be miniaturized by adoption of the piezoelectric transducer of such easy structure, and, moreover, a liquid can be atomized at high effectiveness with this equipment.

[0011] Since said piezoelectric ceramics have the through hole penetrated in parallel with the thickness direction of said piezoelectric ceramics, opening of said through hole is prepared in said oscillating object by at least one place inside the wrap location or this through hole, the vibrational energy of said piezoelectric transducer is efficiently spread on said oscillating object and said oscillating object is vibrated, atomization effectiveness can be increased. Since this oscillating section carries out combination vibration which was united with said piezoelectric transducer when the oscillating object of the part surrounded by the fixing part which has fixed to said piezoelectric transducer accomplishes the oscillating section, the liquid supplied to said oscillating section is atomized by the combination vibration, and stripping is carried out as a fog towards the upper part of said oscillating section. According to the synergistic effect of vibration of said oscillating section, and an operation of the hole established in said oscillating section, the atomization effectiveness of a liquid is promoted, and a misty yield increases, and the path of a particle becomes homogeneity.

[0012] When the form of a cross section perpendicular to the thickness direction of said piezoelectric ceramics constitutes frame type structure and adopts the structure where a ratio with the minimum distance of said thickness lay length, and a said frame type rim and a common-law marriage is equal to about 1, the combination vibration of the complex of said piezoelectric transducer and said oscillating object is reinforced, and atomization effectiveness increases. Moreover, since the combination vibration of the complex of said piezoelectric transducer and said oscillating object is further reinforced by that said frame type is in a circle, atomization effectiveness increases further.

[0013] A means to supply said liquid to said oscillating section is equipped with the liquid-retaining material which absorbs a liquid and supplies this liquid to said oscillating section. Said liquid-retaining material touches the crevice or heights of curve structure in said oscillating section. When said liquid-retaining material touches said crevice, the liquid supplied to said crevice is atomized towards the heights of said curve structure through the hole established in said oscillating section. Moreover, when said liquid-retaining material touches said heights, the liquid supplied to said heights is atomized towards the crevice of said curve structure through the hole established in said oscillating section. The atomization which lets a hole pass can control the direction of the fog which stimulates the minute nature of a particle, and homogeneity and it not only can moreover increase atomization effectiveness, but is atomized. That is, when said liquid-retaining material touches said crevice, the direction of the fog atomized is emitted, and when said liquid-retaining material touches said heights, it converges the direction of the fog atomized.

[0014] Since one opening area of said oscillating section in said hole is larger than the opening area of another side, by using opening of one of these as an entrance side, and making another side into an outlet side, the passage area of the liquid of said hole decreases towards an outlet side from an entrance side. Therefore, when said liquid passes through said hole, said liquid receives wire drawing by said hole. Consequently, a atomization operation of a liquid is promoted by the synergistic effect of said wire drawing and vibration of said oscillating section, and a misty yield increases, and the path of a particle becomes homogeneity.

[0015] By impressing an electrical potential difference in case the resonance frequency of said piezoelectric transducer becomes almost equal to the resonance frequency in the complex of this piezoelectric transducer and said oscillating object to said piezoelectric transducer, said oscillating object is excited efficiently, atomization effectiveness is promoted, and a misty yield increases further.

[0016]
[Example] Drawing 1 is the sectional view showing one example of the ultrasonic atomization equipment of this invention. This example consists of a piezoelectric transducer 1, the oscillating object 2, and a liquid-retaining material 3. To the piezoelectric transducer 1, the terminal which consists of copper foil has fixed with electroconductive glue. The oscillating object 2 is formed in the piezoelectric transducer 1. In drawing 1 , the power circuit and terminal which supply alternating voltage are excluded and drawn on the piezoelectric transducer 1. Near the center of the oscillating object 2 is curving. The liquid-retaining material 3 touches the crevice where the oscillating object 2 curved, and supplies a liquid to the crevice from a liquid-retaining material 3 at the time of use.
[0017] Drawing 2 is the perspective view showing the piezoelectric transducer 1 in the ultrasonic atomization equipment of drawing 1 . A piezoelectric transducer 1 consists of piezoelectric ceramics 11 and Electrodes D and G. It has the through hole which was cylindrical as for piezoelectric ceramics 11, made the end face both sides perpendicular to the polarization shaft, respectively, and was penetrated in parallel with said polarization shaft. The quality of the material of piezoelectric ceramics 11 is TDK72A material (product name), and it is 6mm in the diameter of 24mm, and thickness, and said through hole is also cylindrical and the diameter is 12mm. Since the electromechanical coupling coefficient is large, TDK72A material is used for the example here. Electrode D and Electrode G are formed in said both-ends side, respectively. Terminal P is attached in Electrode D and Terminal Q is attached in Electrode G.
[0018] Drawing 3 is a top view when seeing the complex which consists of a piezoelectric transducer 1 and the oscillating object 2 from a top face. The disc-like oscillating object 2 with which the center section curved is attached in the wrap location in opening of said through hole of the upper limit side of a piezoelectric transducer 1. The oscillating object 2 is a product made from nickel, by the cyclic fixing section 12, was connected with the piezoelectric transducer 1 in one, and is fixed, and the oscillating object 2 surrounded by the fixing section 12 is making the oscillating section 13. The fixing section 12 has fixed to the piezoelectric transducer 1 through Electrode D. The diameter of said through hole is 0.05mm in 14mm and thickness.
[0019] Drawing 4 is drawing showing the cross section of the oscillating section 13 which appears when it cuts at a flat surface perpendicular to a plate surface. The hole 20 of detailed a large number penetrated in the thickness direction is established in the oscillating section 13. The longitudinal-section configuration and dimension of a hole 20 are shown by drawing 4 . The configuration of a hole 20 is a earthenware mortar-like, it uses the thing with one larger opening area than the opening area of another side in the example here, uses one opening as an entrance side, and makes another side the outlet side. The diameter of 0.1mm and an outlet side of the diameter of an entrance side is 0.01mm, and the hole 20 is arranged in the equal pitch.
[0020] Drawing 5 is the partial expansion top view of the oscillating section 13. The configuration, array, and dimension of a hole 20 are shown by drawing 5 .
[0021] At the time of the drive of the ultrasonic atomization equipment of drawing 1 , if the AC signal which has a frequency almost equal to the resonance frequency of the complex of a piezoelectric transducer 1 and the oscillating object 2 is impressed to a piezoelectric transducer 1 through Terminal P and Terminal Q, a piezoelectric transducer 1 will be excited. At this time, the frequency of that AC signal is mostly in agreement with one of the resonance frequency of piezoelectric transducer 1 simple substance. United with a piezoelectric transducer 1, combination vibration of the oscillating section 13 surrounded by the fixing section 12 with excitation of a piezoelectric transducer 1 is carried out. The combination vibration of this oscillating section 13 functions effective in atomization of a liquid. Liquid absorption capacity is large and the liquid-retaining material 3 uses for the example here what has a low acoustic impedance compared with the piezoelectric transducer 1. This is for controlling that the supersonic wave from a piezoelectric transducer 1 spreads and vanishes in a liquid through a liquid-retaining material 3, and vibrating the oscillating object 2 efficiently. The liquid absorbed by the liquid-retaining material 3 reaches the oscillating object 2 of the part in contact with a liquid-retaining material 3, and is led to each hole 20 by capillarity. Since the passage area of the liquid of each hole 20 decreases towards an outlet side from the entrance side when said liquid passes through each hole 20, by the hole 20, said liquid receives wire drawing, serves as a minute and uniform particle, and flows into the outlet side of a hole 20. Consequently, the liquid which flowed out of the hole 20 by the elastic vibration of said wire drawing and the oscillating section 13 is atomized efficiently. According to the ultrasonic atomization equipment of drawing 1 , when applied voltage is 10.7V, the amount of atomization serves as [ a frequency ] max by 290.6kHz, the power consumption at that time is 320mW, and a current is 30mA. Moreover, in the whole equipment including a power source, power consumption is 642mW and a current is 60mA.
[0022]
[Effect of the Invention] Since a liquid is atomized passing through the hole established in the oscillating section

according to the ultrasonic atomization equipment of this invention, the minute nature of a misty particle and homogeneity can be urged. Furthermore, since it has constituted curve structure, if a part of oscillating section [ at least ] is possible, it can close emission of a fog's existence region. A lot of atomization can not only be realized with a low power, but can make the miniaturization of equipment easy from atomization effectiveness being high. Since a self-excitation type drive is also possible and a drive by the cell is also easy, a drive with a low power is attained in the form where it can respond to an environmental variation.

[0023] By adopting the easy structure which consists of piezoelectric ceramics and the electrode currently formed in the both-ends side perpendicular to the thickness direction of the piezoelectric ceramics as a piezoelectric transducer, equipment can be miniaturized, moreover, a liquid can be atomized at high effectiveness, and a drive with a low power is attained.

[0024] When it has the through hole penetrated in parallel with the thickness direction of the piezoelectric ceramics as piezoelectric ceramics, and the form of a cross section perpendicular to the thickness direction constitutes frame type structure and adopts the structure where a ratio with the minimum distance of thickness lay length, and a frame type rim and a common-law marriage is equal to about 1, the combination vibration of the complex of a piezoelectric transducer and an oscillating object is reinforced. Therefore, the vibrational energy of a piezoelectric transducer is efficiently spread on an oscillating object, an oscillating object is vibrated, and atomization effectiveness increases. Furthermore, since the combination vibration of the complex of a piezoelectric transducer and an oscillating object is further reinforced by adopting structure in a circle as a frame type, atomization effectiveness increases further. Moreover, since the vibrational energy of a piezoelectric transducer is efficiently spread on an oscillating object and an oscillating object is vibrated by adopting the structure of preparing opening of a through hole for an oscillating object in a wrap location or the interior of a through hole at at least one place, atomization effectiveness can be increased. Moreover, since an oscillating object changes in the fixing section which has fixed to the piezoelectric transducer, and the oscillating section surrounded by the fixing section, the oscillating section carries out combination vibration which was united with the piezoelectric transducer. Therefore, the solution supplied to the oscillating section is atomized by the combination vibration, and stripping is carried out as a fog towards the upper part of the oscillating section. Vibration of the oscillating section raises the atomization effectiveness of a liquid, and increases a misty yield. In addition, the minute nature of a misty particle can be further improved by using two or more oscillating objects.

[0025] Since the amount of atomization will also increase along with it if applied voltage is made to increase, if an electrical potential difference is changed according to the purpose, the amount of atomization is freely changeable.

[0026] When it has a liquid-retaining material for sucking up a liquid as a means to supply a liquid to the oscillating section, and supplying the oscillating section and the liquid absorption capacity of sponge and others, large moreover, adopts the matter with an acoustic impedance lower than a piezoelectric transducer as the liquid-retaining material Since it not only can supply a liquid efficiently without futility, but propagation into the liquid of the supersonic wave from a piezoelectric transducer is intercepted and the propagation to the liquid-retaining material of excitation of a piezoelectric transducer itself is controlled, excitation of a piezoelectric transducer can vibrate a diaphragm efficiently. Therefore, the atomization effectiveness of a liquid is raised, moreover, abundant atomization of the liquid in a low power is enabled, is united, and the miniaturization of equipment can also be realized easily.

[0027] By adopting the structure of contacting a liquid-retaining material to the crevice of the curve structure in the oscillating section, the liquid supplied to the crevice is atomized towards the heights of curve structure, passing through the hole established in the oscillating section. The atomization which lets a hole pass can emit the direction of the fog which stimulates the minute nature of a particle, and homogeneity and it not only can moreover increase atomization effectiveness, but is atomized. By adopting the structure of contacting a liquid-retaining material to the heights of the curve structure in the oscillating section, the liquid supplied to the heights is atomized towards the crevice of curve structure, passing through the hole established in the oscillating section. The atomization which lets a hole pass can converge the direction of the fog which stimulates the minute nature of a particle, and homogeneity and it not only can moreover increase atomization effectiveness, but is atomized.

[0028] Since the passage area of a liquid decreases towards an outlet side from the entrance side of the hole, when a liquid passes through a hole by adoption of the structure which uses opening of one of these as an entrance side, and makes opening of another side an outlet side since one opening area of the hole established in the oscillating section is larger than the opening area of another side, a liquid receives wire drawing by the hole. Consequently, a atomization operation of a liquid is promoted by the synergistic effect of wire drawing and vibration of the oscillating section, and a misty yield increases, and the path of a particle becomes homogeneity.

[0029] By adopting the structure where the resonance frequency in the complex of a piezoelectric transducer and an

oscillating object becomes almost equal to the resonance frequency of a piezoelectric transducer simple substance, since the combination vibration of the complex of a piezoelectric transducer and an oscillating object reinforces, a misty yield increases further.

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DRAWINGS

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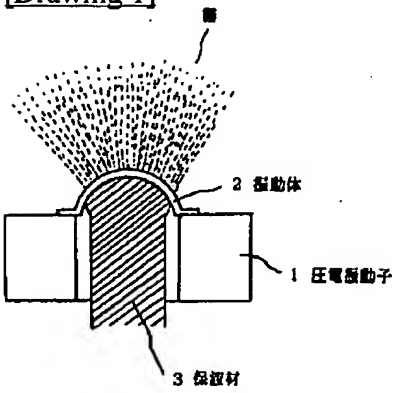
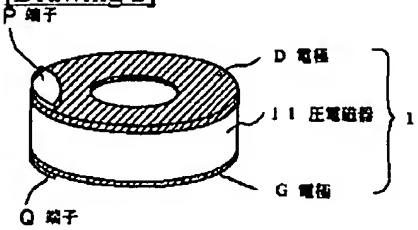
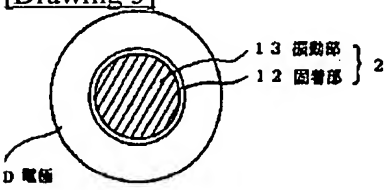
[Drawing 1]



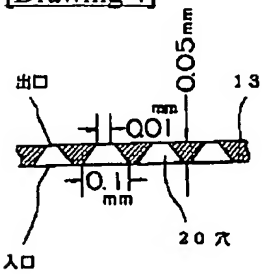

[Drawing 2]



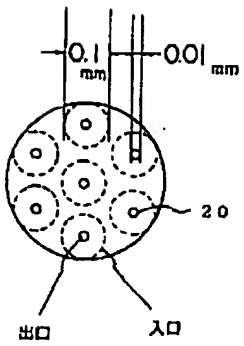

[Drawing 3]




[Drawing 4]




[Drawing 5]

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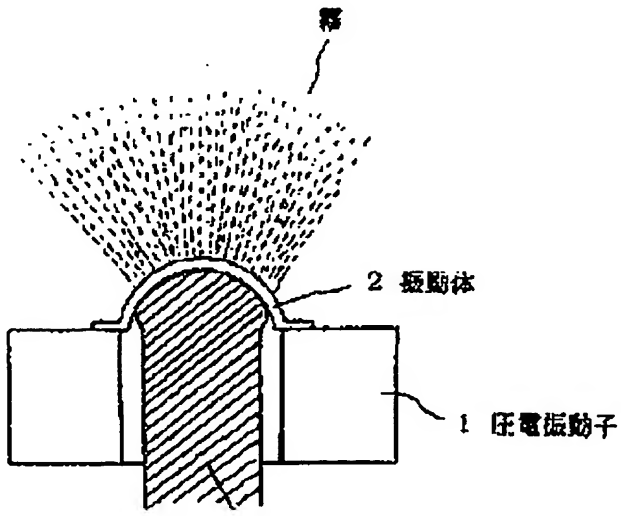
(54)【発明の名称】　超音波霧化装置

(57)【要約】

【目的】　霧化効率、多重霧化、粒子の微小性・均一性、および駆動電源コストのどの面から見ても満足のできる超音波霧化装置を提供する。

【構成】　圧電振動子1と振動体2とから成る複合体を駆動させると圧電振動子1が振動し、その振動は振動体2に伝搬される。保液材3と接触する振動体2の下面に供給される液体は振動体2の振動に伴い振動体2に設けられている穴を通して霧化される。振動体2の中央部が湾曲していることにより霧化方向を発散できる。

【効果】　構造が簡単で小型軽量で、霧化効率、多重霧化、粒子の微小性・均一性を向上できるとともに、霧化方向を発散または収束できる。



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【特許請求の範囲】

【請求項１】　圧電振動子に振動体を固着してなる超音波励振器により発生させた弾性振動により液体を霧化する超音波霧化装置において．

前記圧電振動子は圧電磁器と、該圧電磁器の厚さ方向に垂直な両端面にそれぞれ形成されている電極ＡおよびＢとから成り、

前記圧電磁器は．該圧電磁器の厚さ方向に平行に貫通された貫通穴を有し、前記厚さ方向に垂直な断面の形が枠型構造を成し．前記厚さ方向の長さと．前記枠型の外縁と内縁との最短距離との比がほぼ１に等しく、

前記振動体は．前記貫通穴の開口を覆う位置または該貫通穴の内部に少なくとも１箇所に設けてあり、前記圧電振動子に固着された固着部と、該固着部に囲まれた振動部とから成り．

前記振動部には多数の穴が設けてあり．

前記振動部の少なくとも一部分は湾曲構造を成していることを特徴とする超音波霧化装置。

【請求項２】　前記枠型が円環状であることを特徴とする請求項１に記載の超音波霧化装置。

【請求項３】　前記振動部へ前記液体を供給する手段は．液体を吸収し該液体を前記振動部に供給する保液材を備え、該保液材は前記湾曲構造の凹部または凸部に接触されることを特徴とする請求項１または２に記載の超音波霧化装置。

【請求項４】　前記穴における前記振動部の一方の開口面積と他方の開口面積とが互いに異なることを特徴とする請求項１，２または３に記載の超音波霧化装置。

【請求項５】　前記圧電振動子の共振周波数は．該圧電振動子と前記振動体との複合体における共振周波数にほぼ等しいことを特徴とする請求項１、２，３または４に記載の超音波霧化装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、超音波励振器により発生させた弾性振動により液体を霧化する超音波霧化装置に関する。

【０００２】

【従来の技術】従来の超音波霧化装置としては．ボルト締ランジュバン型振動子を応用した超音波霧化装置およびネブライザーが挙げられる。ボルト締ランジュバン型振動子による霧化装置は数１０ｋＨｚという周波数の超音波を利用したもので、多量の霧を発生しうるという長

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いて難点があった。

【０００３】

【発明が解決しようとする課題】本発明の目的は．霧化効率．多量霧化．粒子の微小性かつ均一性、装置が小型かつ軽量であること、構造が簡単であることおよび駆動電源コストのどの面からみても満足のできる超音波霧化装置を提供することにある。

【０００４】

【課題を解決するための手段】請求項１に記載の超音波霧化装置は、圧電振動子に振動体を固着してなる超音波励振器により発生させた弾性振動により液体を霧化する超音波霧化装置において．前記圧電振動子は圧電磁器と．該圧電磁器の厚さ方向に垂直な両端面にそれぞれ形成されている電極ＡおよびＢとから成り、前記圧電磁器は．該圧電磁器の厚さ方向に平行に貫通された貫通穴を有し．前記厚さ方向に垂直な断面の形が枠型構造を成し．前記厚さ方向の長さと．前記枠型の外縁と内縁との最短距離との比がほぼ１に等しく、前記振動体は．前記貫通穴の開口を覆う位置または該貫通穴の内部に少なくとも１箇所に設けてあり．前記圧電振動子に固着された固着部と、該固着部に囲まれた振動部とから成り．前記振動部には多数の穴が設けてあり、前記振動部の少なくとも一部分は湾曲構造を成していることを特徴とする。

【０００５】請求項２に記載の超音波霧化装置は．前記枠型が円環状であることを特徴とする。

【０００６】請求項３に記載の超音波霧化装置は．前記振動部へ前記液体を供給する手段は．液体を吸収し該液体を前記振動部に供給する保液材を備え、該保液材は前記湾曲構造の凹部または凸部に接触されることを特徴とする。

【０００７】請求項４に記載の超音波霧化装置は．前記穴における前記振動部の一方の開口面積と他方の開口面積とが互いに異なることを特徴とする。

【０００８】請求項５に記載の超音波霧化装置は．前記圧電振動子の共振周波数は．該圧電振動子と前記振動体との複合体における共振周波数にほぼ等しいことを特徴とする。

【０００９】

【作用】本発明の超音波霧化装置の使用時、前記圧電振動子には前記圧電振動子と前記振動体との複合体の共振周波数にほぼ等しい周波数を有する交流信号が印加され前記圧電振動子は励振される。前記圧電振動子の励振は前記振動体を振動させる。前記振動体に供給された液体

動部の少なくとも一部分は湾曲構造を成していることから霧の存在域の発散を可能ならしめることができる。

【0010】前記圧電振動子は圧電磁器と、前記圧電磁器の厚さ方向に垂直な両端面にそれぞれ形成されている電極A，Bとから成る。交流電圧は該電極A，Bを介して前記圧電振動子に印加され、前記圧電振動子は励振される。このような簡単な構造の圧電振動子の採用により超音波霧化装置を小型化でき、しかもこの装置では高い効率で液体を霧化することができる。

【0011】前記圧電磁器は前記圧電磁器の厚さ方向に平行に貫通された貫通穴を有し、前記振動体は前記貫通穴の開口を覆う位置または該貫通穴の内部に少なくとも1箇所に設けられていることから、前記圧電振動子の振動エネルギーは効率良く前記振動体に伝搬し前記振動体を振動させるので、霧化効率を増大させることができる。前記圧電振動子に固着されている固着部分に囲まれた部分の振動体は振動部を成すことにより、該振動部は前記圧電振動子と一体となった結合振動をするから、前記振動部に供給された液体はその結合振動により霧化され前記振動部の上方へ向けて霧として放散される。前記振動部の振動と前記振動部に設けられている穴の作用との相乗効果によって、液体の霧化効率は促進され霧の発生量は増大しかつ粒子の径が均一になる。

【0012】前記圧電磁器の厚さ方向に垂直な断面の形が枠型構造を成し、前記厚さ方向の長さと、前記枠型の外縁と内縁との最短距離との比がほぼ1に等しい構造を採用することにより、前記圧電振動子と前記振動体との複合体の結合振動が増強され霧化効率が増大する。また、前記枠型が円環状であることにより前記圧電振動子と前記振動体との複合体の結合振動がさらに増強されるから、霧化効率がさらに増大する。

【0013】前記振動部へ前記液体を供給する手段は、液体を吸収し該液体を前記振動部に供給する保液材を備える。前記保液材が前記振動部における湾曲構造の凹部または凸部に接触している。前記保液材が前記凹部に接触しているとき、前記凹部に供給された液体は前記振動部に設けられている穴を通して前記湾曲構造の凸部に向けて霧化される。また、前記保液材が前記凸部に接触しているとき、前記凸部に供給された液体は前記振動部に設けられている穴を通して前記湾曲構造の凹部に向けて霧化される。穴を通しての霧化は粒子の微小性、均一性を促しかも霧化効率を増大させることができるばかりでなく霧化される霧の方向を制御できる。すなわち、前記液体が前記穴を通過するときに前記液体は前記穴によって絞り作用を受ける。その結果、前記絞り作用と前記振動部の振動との相乗効果によって液体の霧化作用が促進され、霧の発生量が増加しかつ粒子の径が均一になる。

【0015】前記圧電振動子の共振周波数が該圧電振動子と前記振動体との複合体における共振周波数にほぼ等しくなるときの電圧が前記圧電振動子に印加されることにより、前記振動体は効率的に励振され、霧化効率が促進され、霧の発生量はさらに増大する。

【0016】

【実施例】図1は本発明の超音波霧化装置の一実施例を示す断面図である。本実施例は圧電振動子1、振動体2および保液材3から成る。圧電振動子1には銅箔から成る端子が導電性接着剤によって固着されている。圧電振動子1には振動体2が設けられている。図1では圧電振動子1に交流電圧を供給する電源回路および端子が省いて描かれている。振動体2の中央付近は湾曲している。保液材3は振動体2の湾曲した凹部に接触していて、使用時には保液材3からその凹部に液体を供給する。

【0017】図2は図1の超音波霧化装置における圧電振動子1を示す斜視図である。圧電振動子1は圧電磁器11、電極Dおよび電極Gから成る。圧電磁器11は円柱状でその分極軸に垂直な両面をそれぞれ端面とし前記分極軸に平行に貫通された貫通穴を有する。圧電磁器11の材質はTDK72A材（製品名）で、直径24mm、厚さ6mmで、前記貫通穴も円柱状でありその直径は12mmである。TDK72A材は電気機械結合係数が大きいことからここでの実施例に用いている。前記両端面にはそれぞれ電極Dおよび電極Gが形成されている。電極Dには端子Pが取り付けられ電極Gには端子Qが取り付けられている。

【0018】図3は圧電振動子1と振動体2とから成る複合体を上面方向から見たときの平面図である。圧電振動子1の上端面の前記貫通穴の開口を覆う位置には中央部が湾曲した円板状の振動体2が取り付けられている。振動体2はニッケル製で、輪状の固着部12によって圧電振動子1と一体的に連なって固着されており、固着部12に囲まれた振動体2が振動部13をなしている。固着部12は電極Dを介して圧電振動子1に固着されている。前記貫通穴の直径は14mm、厚さ0.05mmである。

【0019】図4は板面に垂直な平面で切断したときに

直径は0．01mmであって、穴20は等しいピッチで配列されている。

【0020】図5は振動部13の部分拡大平面図である。図5では穴20の形状および配列ならびに寸法が示されている。

【0021】図1の超音波霧化装置の駆動時、圧電振動子1と振動体2との複合体の共振周波数にほぼ等しい周波数を有する交流信号を端子Pおよび端子Qを介して圧電振動子1に印加すると圧電振動子1は励振される。このとき、その交流信号の周波数は圧電振動子1単体の共振周波数のうちの1つにほぼ一致している。圧電振動子1の励振に伴い固着部12に囲まれた振動部13は圧電振動子1と一体となって結合振動する。この振動部13の結合振動が液体の霧化に有効に機能する。保液材3は吸液能力が大きくかつ圧電振動子1に比べて音響インピーダンスが低いものをここでの実施例に用いている。これは圧電振動子1からの超音波が保液材3を介して液体中に伝搬し散失するのを抑制し、振動体2を効率良く振動させるためである。保液材3によって吸収された液体は保液材3と接触している部分の振動体2に達し毛細管現象により各穴20に導かれる。前記液体が各穴20を通過するとき各穴20の液体の通過面積はその入口側から出口側に向けて減少するから、前記液体は穴20によって絞り作用を受け、微小でかつ均一な粒子となって穴20の出口側に流出する。その結果、前記絞り作用、振動部13の弾性振動により穴20から流出した液体は効率良く霧化される。図1の超音波霧化装置によれば、印加電圧が10．7Vのときには周波数が290．6kHzで霧化量が最大となり、そのときの消費電力は320mW．電流は30mAである。また、電源を含む装置全体においては消費電力は642mW．電流は60mAである。

【0022】

【発明の効果】本発明の超音波霧化装置によれば振動部に設けられた穴を通過しながら液体が霧化されるので、霧の粒子の微小性、均一性を促すことができる。さらに、振動部の少なくとも一部分は湾曲構造を成していることから霧の存在域の発散を可能ならしめることができる。霧化効率が高いことから多量の霧化が低消費電力で実現できるだけでなく装置の小型化も容易にできる。自励式駆動も可能で高地での駆動も容易なことから環境変化に対応しうる形で低消費電力での駆動が可能となる。

【0023】圧電振動子として圧電磁器と、その圧電磁



縁と内縁との最短距離との比がほぼ1に等しい構造を採用することにより、圧電振動子と振動体との複合体の結合振動が増強される。従って、圧電振動子の振動エネルギーは効率良く振動体に伝搬し振動体を振動させ霧化効率が増大する。さらに、枠型として円環状構造を採用することにより圧電振動子と振動体との複合体の結合振動がさらに増強されるから、霧化効率がさらに増大する。また、振動体を貫通穴の開口を囲う位置または貫通穴の内部に少なくとも1箇所に設ける構造を採用することにより、圧電振動子の振動エネルギーは効率良く振動体に伝搬し振動体を振動させるので、霧化効率を増大させることができる。また振動体は圧電振動子に固着されている固着部と、その固着部に囲まれている振動部とで成ることから、振動部は圧電振動子と一体となった結合振動をする。従って、振動部に供給された溶液はその結合振動により霧化され振動部の上方に向けて霧として放散される。振動部の振動は液体の霧化効率を高め霧の発生量を増大させる。なお、振動体を複数個用いることにより、さらに霧の粒子の微小性を向上できる。

【0025】印加電圧を増加させるとそれにつれて霧化量も増加するので、目的に応じて電圧を変えれば霧化量を自由に変えることができる。

【0026】振動部へ液体を供給する手段として液体を吸い上げ振動部に供給するための保液材を備え、その保液材としてスポンジその他の吸液能力が大きくしかも音響インピーダンスが圧電振動子よりも低い物質を採用することにより、液体の供給を無駄なく効率良く行うことができるばかりでなく圧電振動子からの超音波の液中への伝搬が遮断され圧電振動子の励振の保液材自身への伝搬も抑制されるので、圧電振動子の励振は効率よく振動板を振動させることができる。従って液体の霧化効率を高めしかも低消費電力での液体の多量霧化を可能にし、あわせて装置の小型化も容易に実現できる。

【0027】保液材を振動部における湾曲構造の凹部に接触させる構造を採用することにより、その凹部に供給された液体は振動部に設けられている穴を通過しながら湾曲構造の凸部に向けて霧化される。穴を通しての霧化は粒子の微小性、均一性を促ししかも霧化効率を増大させることができるばかりでなく霧化される霧の方向を発散できる。保液材を振動部における湾曲構造の凸部に接触させる構造を採用することにより、その凸部に供給された液体は振動部に設けられている穴を通過しながら湾曲構造の凹部に向けて霧化される。穴を通しての霧化は

けて減少するから、液体が穴を通過するときに液体は穴によって絞り作用を受ける。その結果、絞り作用と振動部の振動との相乗効果によって液体の霧化作用が促進され霧の発生量が増加しかつ粒子の径が均一になる。

【0029】圧電振動子と振動体との複合体における共振周波数が圧電振動子単体の共振周波数にほぼ等しくなるような構造を採用することにより、圧電振動子と振動体との複合体の結合振動が増強するから霧の発生量はさらに増加する。

【図面の簡単な説明】

【図1】本発明の超音波霧化装置の一実施例を示す断面図。

【図2】図1の超音波霧化装置における圧電振動子1を示す斜視図。

＊【図3】圧電振動子1と振動体2とから成る複合体の平面図。

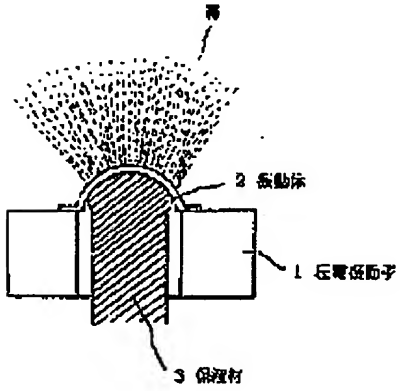
【図4】板面に垂直な平面で切断したときに現れる振動部13の断面を示す図。

【図5】振動部13の部分拡大平面図。

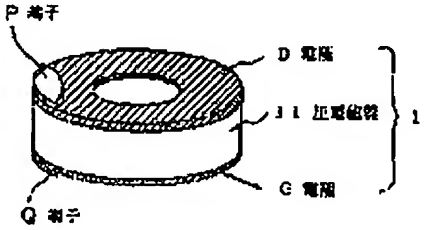
【符号の説明】

| | |
|---|---|
| 1 | 圧電振動子 |
| 2 | 振動体 |
| 3 | 保液材 |
| 11 | 圧電磁器 |
| 12 | 固着部 |
| 13 | 振動部 |
| 20 | 穴 |

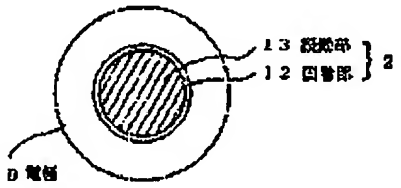
【図1】



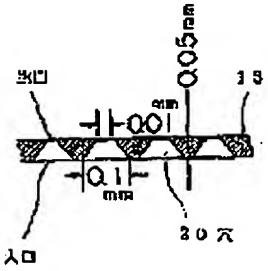

【図2】




【図3】




【図4】




【図5】